Naval S&T Strategic Plan

Defining the Strategic Direction for Tomorrow

OFFICE OF NAVAL RESEARCH

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Naval S&T Strategic Plan. Defining the Strategic Direction for Tomorrow	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Office of Naval Research,One Liberty Center ,875 North Randolph Street, Suite 1425,Arlington,VA,22203-1995**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**49**	

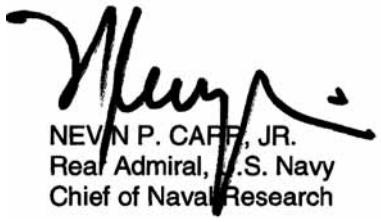
Foreword

The Naval Science and Technology (S&T) Strategic Plan describes how the Office of Naval Research (ONR) will implement our strategy by making investments that enable the future operational concepts of the Navy and Marine Corps. The Strategic Plan was developed by program officers from ONR and the Naval Research Laboratory (NRL) with diverse educational and research backgrounds under the leadership of two ONR senior executives. It began with a detailed analysis of the Department of the Navy's (DON) topdown guidance and an assessment of how best to meet naval capability needs. By design, it is a broad strategy that provides direction for the future but also ensures the requisite flexibility for ONR to fully address emerging challenges or alter course as directed by senior Naval leadership. The Naval S&T Corporate Board approved the Strategic Plan and directed the Chief of Naval Research to publish and implement the plan.

This document is a refinement of the Naval S&T Strategic Plan published in January 2007. It addresses the changes in guidance articulated in the various DON strategic documents published in the intervening two years. The development of this strategy was undertaken with a view to engaging DON senior leadership, agencies, partners, and customers both within and outside the naval domain to obtain and incorporate feedback.

The Naval S&T Strategic Plan serves three principal goals: (1) Aligns Naval S&T with Naval mission and future capability needs; (2) Balances and manages the S&T portfolio, and (3) Communicates the S&T vision and approach to senior decision-makers, key stakeholders, S&T partners, customers, and performers.

ONR's execution of the S&T Strategic Plan will ensure the continued technological superiority advantage of our Naval forces. The ultimate goal of our investments in science and technology is that no Sailor or Marine will ever find themselves in a fair fight. Our technology must place them in a dominant position in any battlespace against all threats -- and keep them there.



NEVIN P. CARR, JR.
Rear Admiral, U.S. Navy
Chief of Naval Research

DEPARTMENT OF THE NAVY
1000 NAVY PENTAGON
WASHINGTON, DC 20350-1000

MEMORANDUM FOR THE CHIEF OF NAVAL RESEARCH

Subj: SCIENCE AND TECHNOLOGY CORPORATE BOARD DECISION MEMORANDUM

1. The Corporate Board endorses and approves the Naval Science and Technology Strategy presented at the 3 December 2008 Science and Technology Corporate Board meeting and directs the Chief of Naval Research to implement the strategy.

JAN 05 2009	FEB 26 2009	FEB 02 2009
J. F. Amos General, U.S. Marine Corps Assistant Commandant of the Marine Corps	P. M. Walsh Admiral, U.S. Navy Vice Chief of Naval Operations	Sean J. Stackley Assistant Secretary of the Navy Research, Development and Acquisition

Table of Contents

1.0 Introduction

The Naval Science and Technology (S&T) Strategic Plan describes how the Office of Naval Research (ONR) will enable the future operational concepts of the Navy and the Marine Corps. By design, it is a broad strategy that provides strong direction for the future, while retaining sufficient flexibility and freedom of action to allow ONR to meet emerging challenges or alter course as directed by senior Naval leadership.

As the Department of the Navy's (DON) science and technology (S&T) provider, the Office of Naval Research (ONR) provides S&T solutions for Navy and Marine Corps needs. Our mission, defined by law, is to "plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security" [1]; and to "manage the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation." [2]

Naval S&T Vision: Sponsor scientific research and technology to:

- Pursue revolutionary capabilities for Naval forces of the future
- Mature and transition S&T advances to improve naval capabilities
- Respond to current critical needs
- Maintain broad technology investments both to hedge against uncertainty and to anticipate and counter potential technology surprise.

The Naval S&T Corporate Board is composed of the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN-RDA), the Vice Chief of Naval Operations (VCNO), and the Assistant Commandant of the Marine Corps (ACMC). Its 3 May 2005 guidance directed the Chief of Naval Research (CNR) to develop a Naval S&T strategy. This strategy ensures that ONR's investments both respond to naval needs and support innovative naval operational concepts. Based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, OPNAV, and HQMC), this strategy has three principal goals:

- Ensure alignment of Naval S&T with Naval missions and future capability needs
- Balance and manage the S&T portfolio
- Communicate the S&T vision and approach to senior decision-makers, key stakeholders, S&T partners, customers and performers

The ONR vision and the role of S&T are discussed in the following sections. Section 2 provides background on balancing the S&T investment portfolio,

Section 3 describes the strategy development process, and Section 4 describes the 13 S&T focus areas that were derived based on naval capability needs. Section 5 describes the Naval Research Enterprise (NRE) and outlines the current ONR approach to providing the S&T necessary to support these capabilities. Section 6 highlights some high-impact future Navy and Marine Corps capabilities that will be enabled by successful implementation of this strategy. Section 7 provides a summary and link to the ONR website.

[1] Public Law 588 of 1946. [2] Defense Authorization Act of 2001.

2.0 Background

To meet current and emerging warfighter needs and deliver future force capabilities, ONR invests in mid- and long-term research while allowing for responsive, limited near-term technology insertions. Figure 1 shows the key components of our portfolio and, by percentage, how the DON's S&T funds are distributed. The CNR uses the remaining 10 percent to reinforce these areas and to accelerate developments for high-priority programs. S&T's role is not to avoid risk, but to take scientifically feasible risk. ONR investigates new ideas to generate technology options and mitigate risk in acquisition. S&T also investigates a variety of technical solutions that can significantly lower the total ownership cost of military systems.

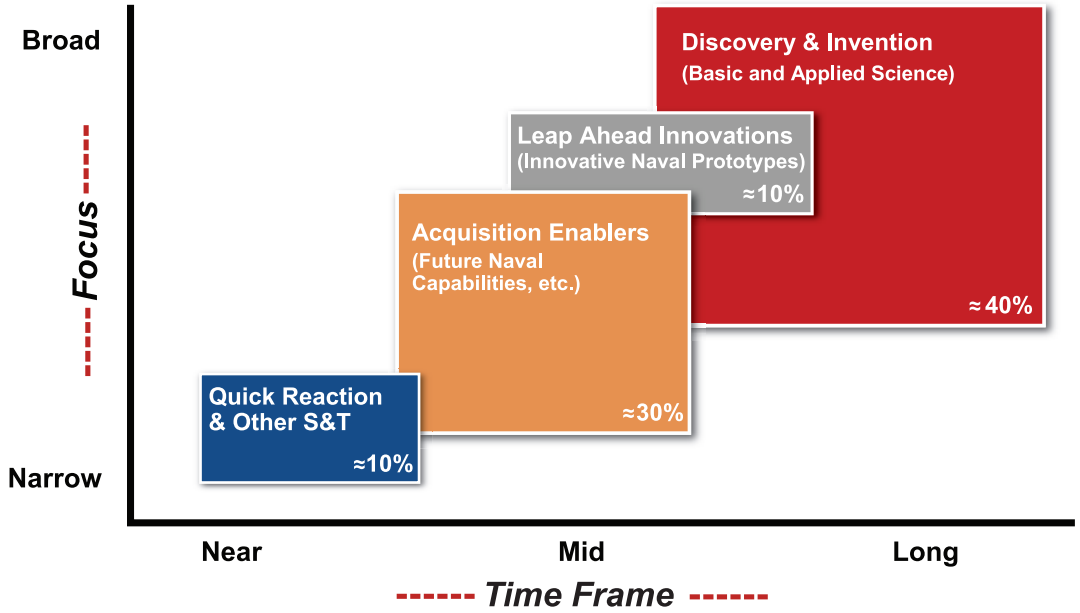


Figure 1. S&T Focus vs. Time

The balanced S&T portfolio illustrated in Figure 1 produces both knowledge and products that contribute to long-term DON strategic goals. The following is a brief explanation of each category:

- Discovery and Invention (D&I) consists of Basic Research (Budget Activity (BA) 6.1) and early Applied Research (BA 6.2), and is the seed corn for future naval technologies and systems. The D&I portfolio, by design has a broad focus, and programs are selected based on potential naval relevance and technology opportunity. D&I investments leverage other service, governmental, department, industry, international and general research community investments. The D&I portfolio supports sustained funding of the four National Naval Responsibilities (NNR): Ocean Acoustics, Underwater Weaponry, Naval Engineering and Undersea Medicine (See Section 5.1 for an explanation of the NNR's).

- Leap Ahead Innovations include Innovative Naval Prototypes (INPs) and Swampworks, and are technology investments that are potentially "game changing" or "disruptive" in nature. INPs achieve a level of technology suitable for transition in four to eight years. Swampworks efforts are smaller in scope than INPs and are intended to produce results in one to three years. This category is where we typically accept higher risk in an effort to produce higher payoff for the warfighters.

- Acquisition Enablers center on the Future Naval Capabilities (FNCs). These work to mature technology into requirements-driven, transition-oriented products in the late stages of Applied Research and Advanced Technology Development (BA 6.3). FNCs provide enabling capabilities to fill gaps in OPNAV and MCCDC requirements analyses identified in the Navy and Marine Corps strategies and Naval Power 21. In addition to FNCs, ONR also uses Small Business Innovative Research (SBIR), Manufacturing Technology (MANTECH) programs and Rapid Technology Transition (RTT) to foster naval acquisition programs' success.

- Quick Reaction S&T includes ONR Tech Solutions and Navy/Marine Corps Experimentation. These are quick-reaction projects responsive to the immediate needs identified by the fleet, operating forces, or Naval leadership.

See Section 5 for a more detailed explanation of the S&T portfolio, and Appendix A for helpful related web links.

S&T supplies the pipeline of knowledge, concepts, and prototypes that leads to products and builds a cadre of scientists, engineers, and researchers focused on naval issues and challenges. Without this pipeline, the United States would be at risk of losing its Naval forces' technological advantage. Many technologies ONR sponsored at University Affiliated Research Centers (UARC), Navy laboratories, academia, and industry have yielded solutions to emerging problems and provided the fertile ground in which to grow our scientific community. The Fiber-optic Lightweight Wide Aperture Array for Virginia-class nuclear submarines, radar wave form and signal processing for detection of low-

observable and sea-skimming targets in the AN/SPQ-9B radar, software-definable radio processes and mechanisms for the Joint Tactical Radio System, Immersive Infantry Training simulation, autonomy in support of all types of unmanned vehicles, flexible body armor technology and helmet design for improved personnel protection are some excellent recent examples. Such successes are only possible when experienced scientists with the necessary tools and expertise are in place.

2.1 Management Approach: Selecting research for future Naval force capabilities must be balanced with fiscal realities. This has presented a very challenging investment environment. ONR therefore manages the diverse Naval S&T portfolio to:

- Address enduring naval needs and ensure every S&T dollar contributes maximum impact
- Maintain investments and intellectual capital in areas unique to the Navy and Marine Corps
- Encourage new researchers and stimulate competitive research with technically proficient program officers and efficient business processes
- Seek partnerships that complement or enhance S&T outputs
- Encourage informed risk-taking and learn from failure
- Provide pathways for transitioning S&T outputs, including interactions between the S&T community and potential technology users in early stages
- Counter technological surprise
- Hedge against uncertainty

2.2 S&T Outputs: S&T investments enable the technical superiority of our Naval forces by producing knowledge, transitions, and people. These are briefly described below. Section 5.10 Measuring Success contains the Metrics associated with each of these S&T outputs.

- **Knowledge:** Scientific discovery generates new technologies that expand capabilities and enable innovative concepts of operations. Knowledge (gained from both successes and failures) leads to new technology pathways and reduces technical risk in later stages of research and development. ONR Program Officers constantly evaluate the cutting-edge of science and technology for potential breakthroughs in naval capabilities, and maintain knowledge of worldwide developments in their disciplines.

- **Transitions:** ONR strives to provide viable paths for scientific discoveries and maturing technology to transition to the DON, the broader DoD, industry, and — ultimately — the warfighter. ONR programs and business practices ease transition and bridge the “valley of death” between S&T and acquisition programs.

- **People:** ONR is dedicated to developing the S&T workforce the United States needs to maintain its technological superiority. More than half of ONR's Basic Research funding goes to university programs. In addition to grants to individual investigators, fellowship programs support faculty, graduate, and undergraduate education of U.S. citizens who plan to work in Navy laboratories. Special programs also support the education and professional development of minority students and faculty members.

2.3 S&T Enablers: Two fundamental enablers for Naval S&T are global technology awareness and the science and engineering workforce and performer base. Global technology awareness is vital to mitigating technological surprise and exploiting international technology advancements. In our quest to identify the best performers and most promising technologies for the Navy and the Marine Corps, we strive to reach out and access intellectual capital worldwide. Central to our mission is ensuring the supremacy of naval technology; therefore, we must maintain the requisite U.S. S&T capacity and expertise. Naval S&T fosters the education and professional development of the science and engineering workforce in support of the NRE. These enablers will be discussed further in Sections 5.1 thru 5.8.

3.0 Strategy Development

Events of the past decade have dramatically transformed the strategic landscape in ways that "compel the Navy…to develop a strategy that informs investments for a future marked by uncertainty, irregular and increasingly unrestricted warfare, and potentially, conventional campaigns against technologically sophisticated adversaries."[3] Investments to address these security challenges will be made in an increasingly complex, uncertain and potentially constrained fiscal environment. We must strive to effectively leverage our S&T investments with our partners. The global flow of technology, information and ideas provides both opportunities and challenges. "The U.S. Navy is the most technologically advanced Fleet in the world and has traditionally dominated the battlespace through a commitment to both present and future technology capability. To ensure that the Navy can both preserve technological superiority and security while capitalizing on the best and brightest ideas globally, we must recognize the importance of S&T as a driver of both capability and threat."[4] This dynamism and its attendant uncertainties require a Naval S&T portfolio that is both balanced and diligently prioritized.

[3] Navy Strategic Plan in Support of POM 2008, August 2006. (Unclassified - paragraph)
[4] Navy Strategic Plan in Support of POM 2010, November 2007. (Unclassified - paragraph)

3.1 Hedging Against Uncertainty: S&T provides the DON the means to be agile in adapting to unforeseen risks and a strong foundation of cutting edge warfighting capability. To support the Department's ability to access the right capability and capacity for the fight at hand and in the future, ONR manages a balanced investment portfolio, as previously described in Section 2 and explained more fully in Sections 5.0 thru 5.4.

ONR also manages the naval "hedge fund" for a changing world. S&T provides a cost-effective approach to providing a range of capabilities that can be pulled rapidly into acquisition as risks or opportunities emerge globally. In doing so, ONR maintains a strong connection not only with the Fleet/Force, but also with the global academic, industrial, and government science and technology communities, as described in Sections 5.6 and 5.7. While retaining its long term orientation, ONR's portfolio balance ensures the ability to quickly re-direct resources as needed, sometimes slowing, sometimes accelerating or altering the development and fielding of a given technology as dictated by the evolving pace and nature of emerging threats and opportunities.

3.2 Strategy Process: The Naval S&T strategy is developed from the top down. Key guidance documents provide an underpinning of Navy and Marine Corps missions, force capabilities, and technology needs in the context of DoD goals.

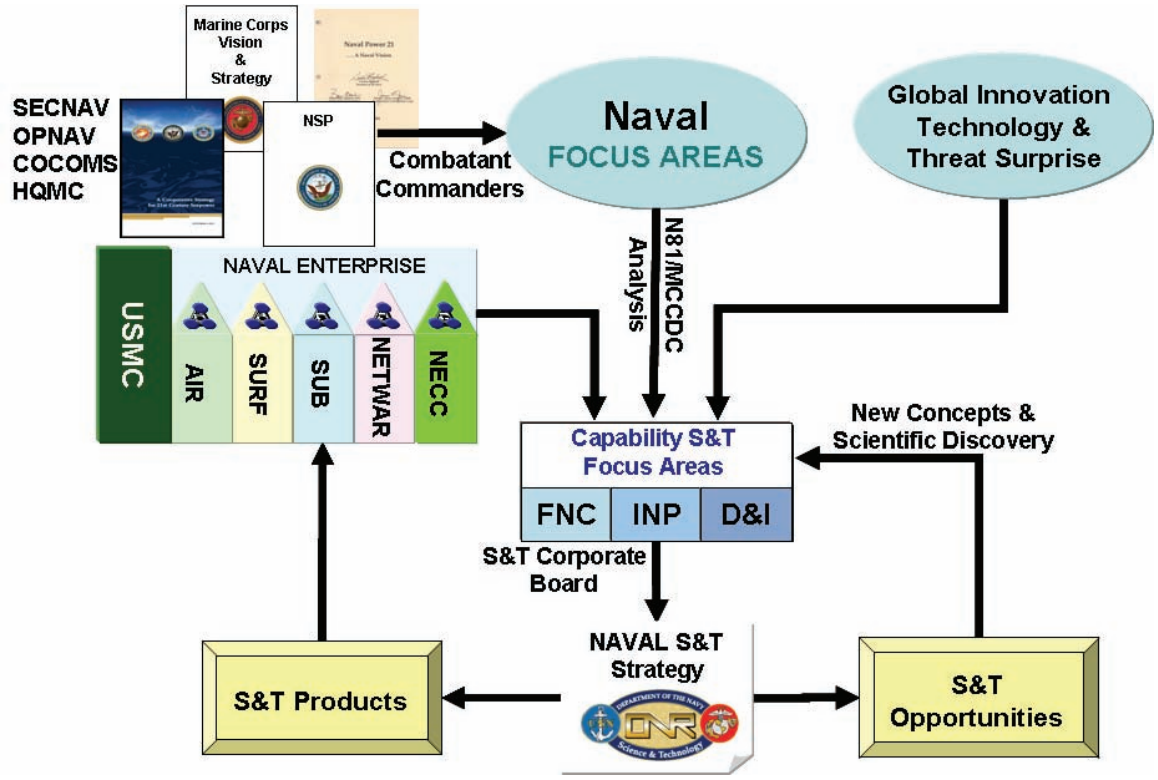


Figure 2: Naval S&T Strategy Process

The strategic planning process (Figure 2) distills critical Naval needs from formal guidance and stakeholder input. From that input the Naval S&T focus areas (Section 4) have been developed. A list of references and relevant guidance considered in the development of the focus areas is provided in Appendix A.

- Naval Focus Areas: *A Cooperative Strategy for 21st Century Seapower, Naval Power 21, Navy Strategic Plan, Marine Corps Vision and Strategy* and the warfare capability analysis conducted by OPNAV N81 and MCCDC describe Naval focus areas with key elements tied to mission needs and security challenges.

- Naval Enterprise and USMC Input: ONR has directly collected Naval enterprise and Marine Corps capability needs and technology objectives. Specific S&T inputs include the Marine Corps and Enterprise S&T strategic plans, a partial list of those reviewed can be found in Appendix A.

- Technology and Threat Surprise: The scope of the S&T that covers each naval capability area is defined and where necessary expanded to project future security threats based on technology feasibility. Where feasible, disruptive inputs within each capability area have been considered to identify research priorities for the S&T portfolio.

- S&T Opportunities: Broad investments lead to scientific discovery and technology options applicable to naval needs. Including S&T opportunities in the planning process feeds new knowledge back into the S&T priority-setting process.

3.3 Strategy Timeframe: The Naval S&T Strategic Plan will be revised at two-year intervals to keep current with user needs and technology opportunities. This allows ONR to provide current guidelines for S&T programs and focus communications between the researcher and user communities.

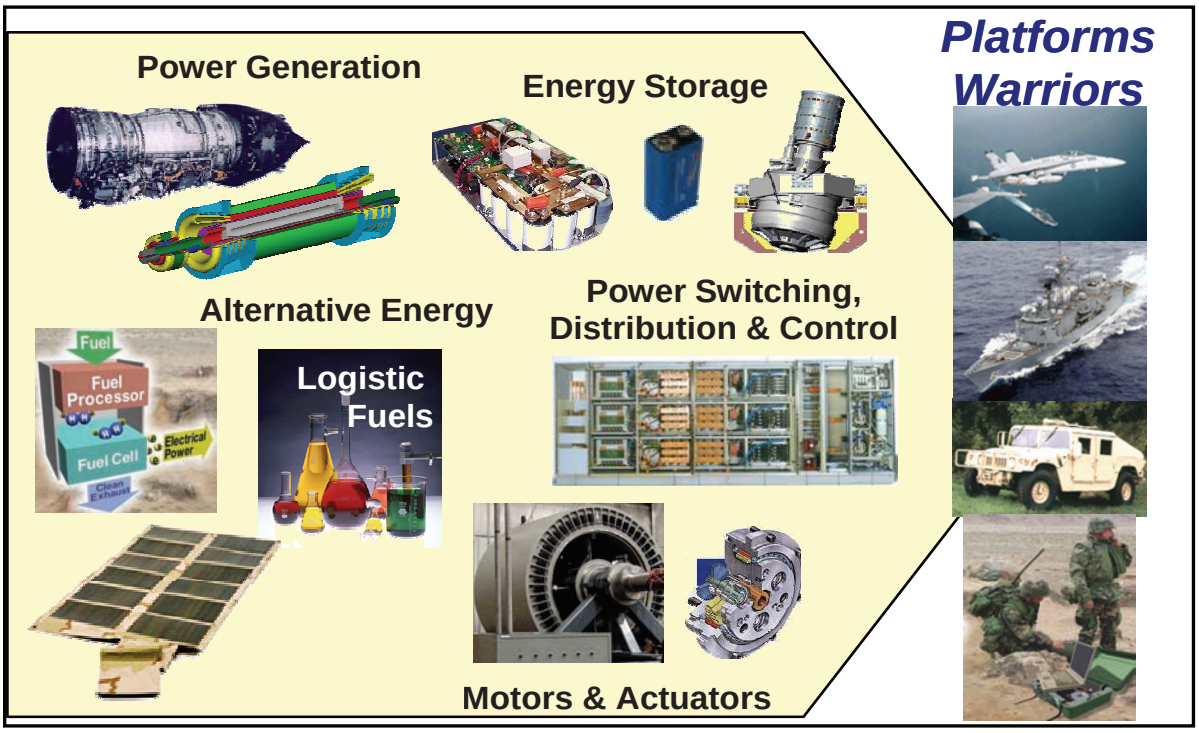
3.4 S&T Taxonomies: While implementation of the Strategic Plan centers on the S&T Focus Areas (discussed in the next Section) which are based on naval capability needs, there are also other approaches to describing the S&T investment portfolio. One used regularly to manage the portfolio and make investment decisions is referred to as the S&T Taxonomy of Research Areas and Research Sub-areas (RA/RSA). Its structure is orthogonal to the Focus Area approach, in that it identifies specific fields of science and technology investment. Currently there are 14 major Research Areas broken into 80 Research Sub-areas. Appendix B identifies the Research Sub-areas associated with each Focus Area. Since Sub-areas are technology-based whereas the Focus Areas are capability-based, an investment in a particular Sub-area, like Solid State Electronics, often supports several Focus Areas. The S&T Research Areas and Sub-areas illustrate the total investment in a particular science or technology, and indicate how a single investment can be leveraged to satisfy multiple Focus Area needs.

4.0 Naval S&T Focus Areas

For each of the 13 focus areas, the following sections provide a synopsis of the S&T vision, high-level objectives, and pictorial representations that were presented to and approved by the Naval S&T Corporate Board. These highlight how S&T can advance Naval capabilities and will guide our investments. The corresponding S&T Research Sub-areas are listed in Appendix B. The Naval S&T Focus Areas are:

- Developed from naval needs
- Embody durable or enduring themes
- Sized for reasonable scale and magnitude
- Traced directly from warfighting functions

4.1 Power and Energy



Vision: Increase Naval forces' freedom of action through energy security and efficient power systems, to provide desired power at the manned/unmanned platform, system, and personal levels.

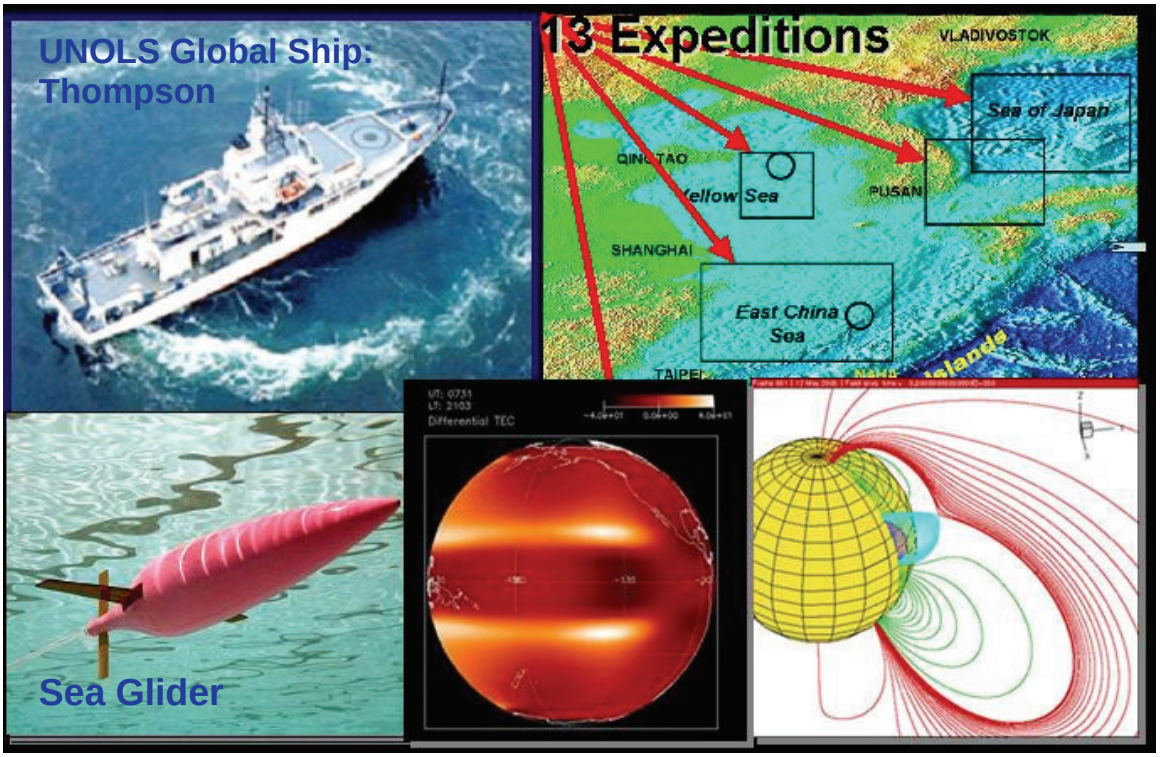
Description: Efficient and secure power systems for Naval forces must be developed to provide the required power when and where needed. The goal is to combine efficient power conversion technologies with a wide range of energy

sources that will provide reliable power for all non-nuclear naval ground, air, and sea systems.

Objectives:

- Energy Security
  - Alternative and renewable energy sources
  - Future logistics tools
  - Resilient power networks and systems
- Efficient Power and Energy Systems
  - Materials, devices and architectures to increase efficiency, and power density for platforms, and reduce weight for personal power
  - Efficient power conversion, switching, distribution, control and thermal management
  - Engines, motors, generators and actuators
  - Electrochemical, thermal and kinetic energy storage
- High Energy and Pulse Power
  - Energy storage power system architectures
  - Energy pulsed power switching and control systems

4.2 Operational Environments



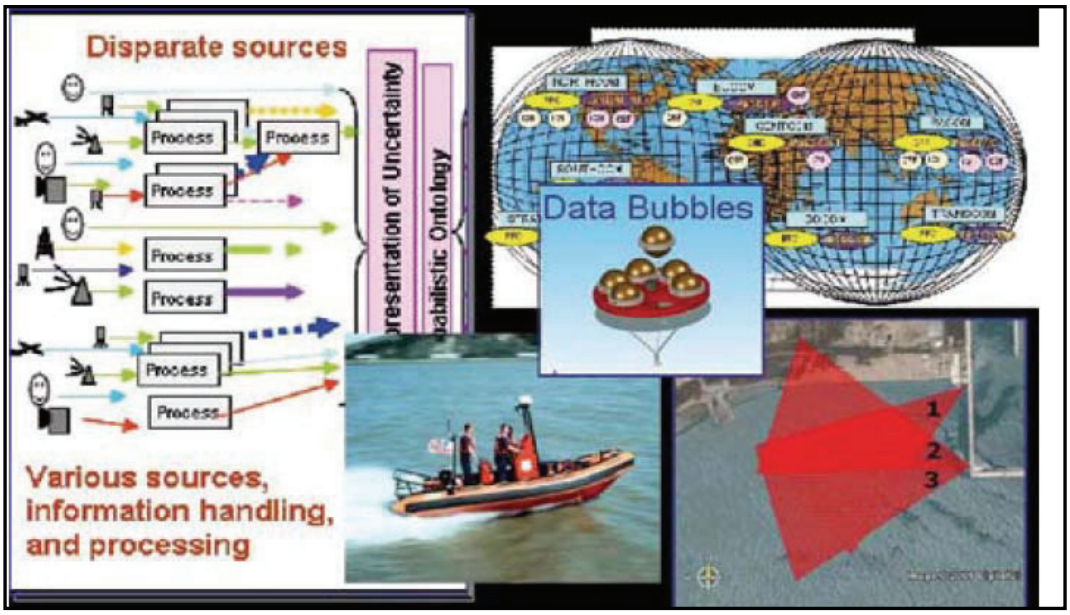
Vision: Exploit the environment to our tactical advantage by accurately predicting the ocean, air, littoral, and riverine environments on tactical and strategic time scales.

Description: Naval forces operate on, under, and above the sea, on land, and in the littoral reaches all over the world. Naval forces require precise knowledge of how the environment will impact operations in order to gain tactical advantage against adversaries who are intimately familiar with their home environments. To accomplish this objective, the Navy and Marine Corps need to exploit every aspect of the diverse environment in which they operate. Critical to their success is the development of an understanding and synthesis of littoral and selected ocean air and/or ocean processes at high resolution of space and time scales as they impact naval operations. To do this they need real-time, environmentally adaptive sensors, processing, systems, and strategies. The development and use of distributed and autonomous ocean systems is a vital aspect of this need. Innovative approaches (requiring neither complete nor perfect knowledge) to modeling and simulations of complex environments, including interactions with systems, form a key part of this challenge. Along with this, we need innovative means to evaluate assimilation, modeling, and simulation methods.

Objectives:

- Mobile Autonomous Environment Sensing
  - Autonomous sensing of ocean and littorals to Beach Exit Zone
  - Actionable environmental sensing that automatically adapts sensing strategy to changing conditions
- Match Predictive Capabilities to Tactical Planning Requirements
  - Ocean-atmosphere coupled global, regional, and local modeling and prediction for operational planning
  - Forecasts for refractivity, duct heights, fog, rain, clouds, visibility, trafficability, tropical cyclones at global, regional and tactical scales to increase mission go/success
- Adapt Systems to the Environment
  - Methods to account for acoustic and electromagnetic propagation, scattering, ambient noise, and bottom effects
  - Automated sensor and weapons performance prediction and reconfiguration
  - Impact/response for space environmental effects

4.3 Maritime Domain Awareness



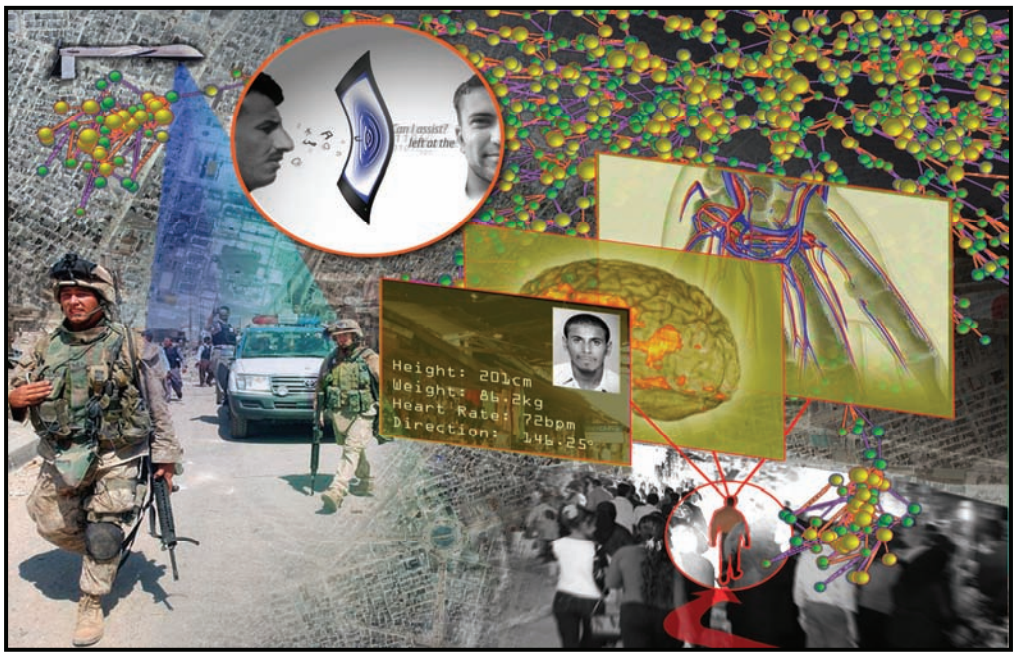
Vision: Locate and track any target of interest on, under and above the water extending to 250 nm ashore using integrated networks of persistent sensors.

Description:
Successful prosecution of the Global War on Terror (GWOT) depends greatly on our situational awareness of the battlespace. For the Naval forces, that battlespace is the maritime domain. Today's security challenges will test our ability to gain awareness and understanding, and our ability to seize the initiative against our adversaries. Whereas in the past our adversaries have usually been conventional forces vulnerable to traditional means of combat, our current adversaries are elusive, widely distributed, and employ irregular tactics. The Navy and Marine Corps must build and maintain global maritime domain awareness to generate actionable intelligence. Maritime domain awareness includes effective knowledge of all activities within the naval maritime environment–from blue water to the littorals and riverine areas—that affect the security of the United States. It also includes effective dissemination of that knowledge.

Objectives:
- Pervasive and Persistent Sensor Networks
  - All domain coverage
  - Mission-focused autonomy with near real-time self-tasking
  - Secure, survivable, self-healing, adaptable and affordable
- Identification of Hard Targets through Diverse Sensing
  - Identification of entities and events via electromagnetic signatures
  - Development of SIGINT capability to understand human activity

  - Characterization of acoustic signatures
  - Use tagging, tracking and location to de-clutter battlespace picture
- Sensor / Data Integration and Threat Assessment
  - Automated image, video and SIGINT processing
  - Rapid, accurate, multi-source data integration including national and tactile sensors, intel and open-source data
  - Automated decision tools
  - Automated ISR sensor re-taskings to refine battlespace knowledge
  - Automated assessment of events and entities to determine intent

4.4 Asymmetric and Irregular Warfare



Vision: Enable Naval forces to identify, anticipate, preempt, and defeat adaptive irregular threats operating within the complex physical, cyber, and socio-cultural domains.

Description: Irregular warfare (IW) includes the struggle among state and non-state actors for legitimacy and influence over relevant populations. IW favors indirect and asymmetric approaches that involve acting, organizing, and thinking differently than one's opponent in order to circumvent or undermine his strengths while exploiting his weaknesses. This combination of Asymmetric and Irregular Warfare (AIW) that will characterize future conflicts has inspired the emerging operational concept of complex hybrid warfare. While AIW technology investments will enhance Naval warfighter capabilities within the physical domain (with a focus on the littoral environment), AIW will also place a premium on technologies that increase our ability to understand, influence, and effectively "maneuver" within the human (cognitive/cultural) and virtual

(information/cyber) dimensions of the modern battlespace. These investments will additionally support an evolving Operational Adaptation (OA) concept. OA enablers will enhance our ability to accurately forecast threat actions; preempt and defeat threat adaptations; maintain decision cycle superiority; and accurately assess operational options across all relevant domains. Naval technology investments will further seek to minimize two critical irregular threat capabilities - hiding within the local population and achieving strategic influence through the use of Improvised Explosive Devices (IEDs). Ultimately, these investments will enable Naval warfighter dominance over an ever-adapting irregular threat operating within the chaos, disorder, uncertainty, and complexity of the Irregular Warfare battlespace.

Objectives:

- Irregular Warfare Battlespace Awareness
  - Adaptive planning and direction of collection assets
  - Sensors and sensor systems for observation and collection
  - Data fusion and analysis for actionable intelligence generation
  - Shared situational awareness and understanding
- Socio-Cultural Domain Analysis
  - Persona identification and understanding
  - Social, cultural, and behavioral data understanding and collection
  - Social network identification, understanding and modeling
  - Threat behavior detection, understanding and modeling
- Influence Operations Enablers
  - Operational culture learning and language
  - Adaptive thinking and leader development
  - Adaptive planning, wargaming and tactical decision tools
- Advanced Countermeasures
  - Counter asymmetric weapons and CIED
  - Counter intelligence and surveillance detection
  - Tactical site exploitation, forensics and biometrics
  - Human and irregular platform tagging, tracking and locating

4.5 Information Superiority and Communication

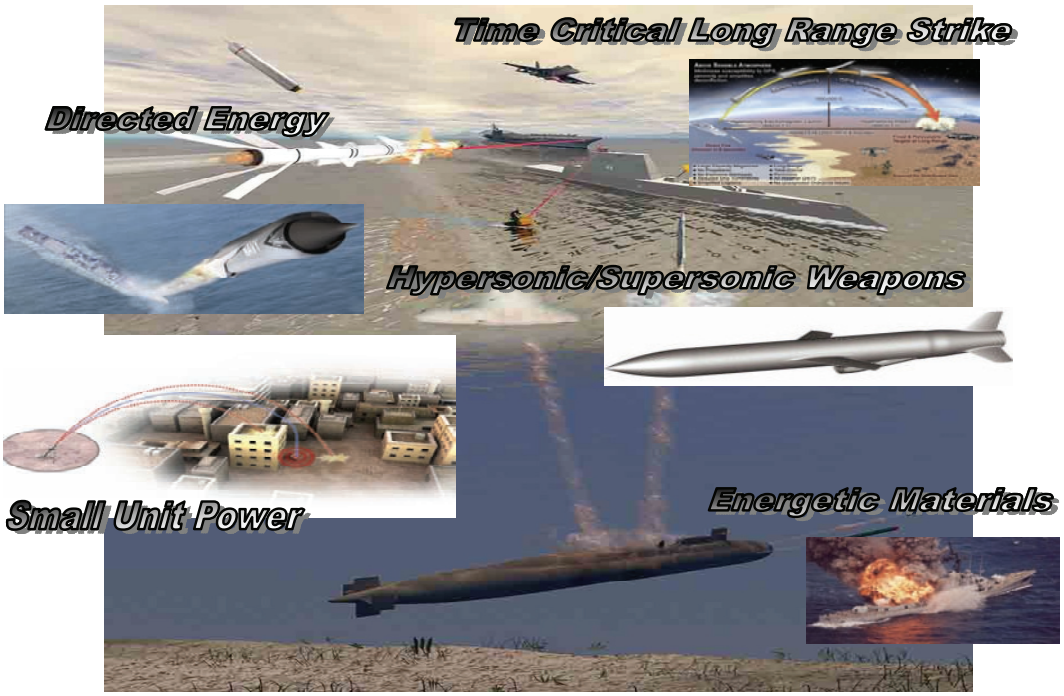
Vision: Enable the warfighter to take appropriate action against any threat by assuring that automated, continuous analyses of all information sources are fully integrated to provide optimized courses of action.

Description:
Information superiority and communication involves employment of dynamic, flexible structures consisting of both current and planned national and theater assets. This focus area encompasses automated data processing capabilities, communications and information requirements. It also provides national, geographic combatant, operational, and tactical commanders with the full range of intelligence required for planning and conducting operations. It includes both technical systems and processes for capturing, structuring, diffusing and re-using knowledge; roles and responsibilities for making things happen; and a culture and style that promote communication and sharing.

Objectives:
- Rapid, Accurate Decision-Making
  - Enhanced human decision-making while reducing the time spent filtering data and information
  - Automated graphical representation of commander's intent
  - Automated understanding and integration of all data types
  - Automated generation and management of courses of action
  - Decision aids with smart algorithms for optimum action
  - Information assurance – authenticity, accessibility, and validity

- Communications and Networks with Increased Throughput
  - Networked architecture for real-time operations
  - Mobile, dynamic, ad hoc networking
  - On-demand reach-back of systems
  - Quality-of-service mechanisms and commander's intent
  - Autonomous monitoring and control of tactical communications and networks
  - Computer Network Security
- Cyber Warfare
  - Computer network attack
  - Computer network exploitation

4.6 Power Projection



Vision: Enable precise extended range indirect fires, time-critical power on target and control of collateral damage through electromagnetic kinetic projectiles, hypersonic missile propulsion and scalable effects weapons.

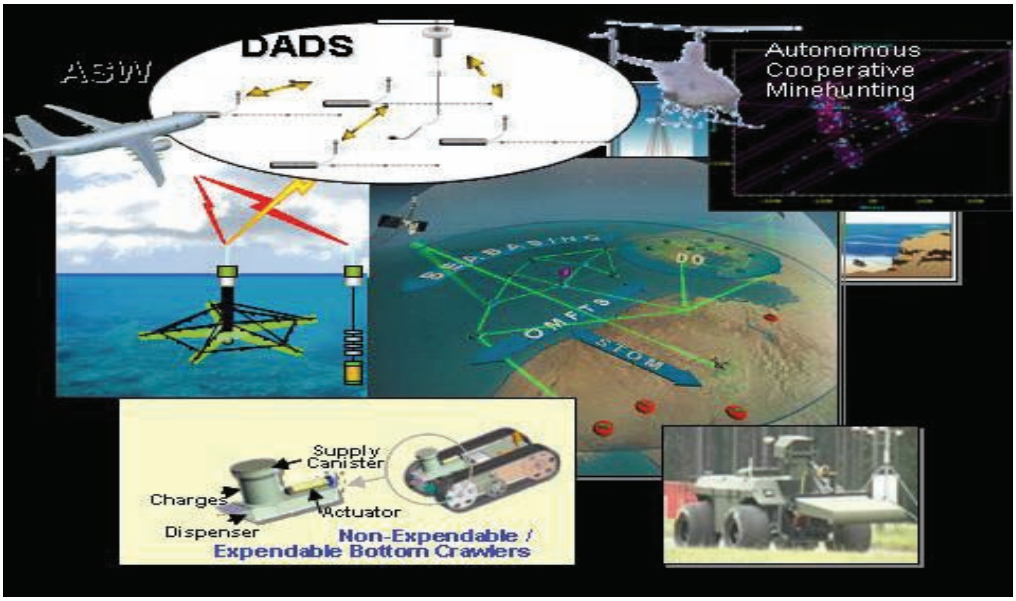
Description: Development and delivery of decisive effects are critical; this effort includes targeting, decision support, and precision strike by air, surface, and undersea platforms. This focus area strives for significant enhancements in naval deliberate and time-sensitive naval strike capabilities, combined with bold ship-to-objective maneuver operations to enhance the ability of Naval forces to damage, seize, or destroy enemy forces at extended ranges in the littorals, deep inland, and on the high seas. Strike emphasizes the employment of these

capabilities at a speed and rate that defeats any adversary's ability to conduct effective operations against us despite his use of mobility and deception to neutralize our efforts.

Objectives:

- Future Navy Fires
  - Increased fires volume and accuracy
  - GPS-denial compensation
  - Indirect fires to 250 miles from safe offshore locations
  - Long-range surface warfare capability
- Control Collateral Damage
  - Scalable effects weapons
  - Selectable/directional lethality
- Time Critical Strike
  - Hardened target/moving target reach and destroy
  - Worldwide to meet warfighter requirements
- Small-Unit Combat Power
  - Increased small unit weapon lethality
  - Neutralize larger hostile forces
  - Application of Joint Fires
  - Advanced weapon sights, including multi-spectral
- Combat Insensitive Munitions
  - Reduce system sensitivity to sympathetic detonation
  - Maintain payload range and lethality

4.7 Assure Access and Hold at Risk



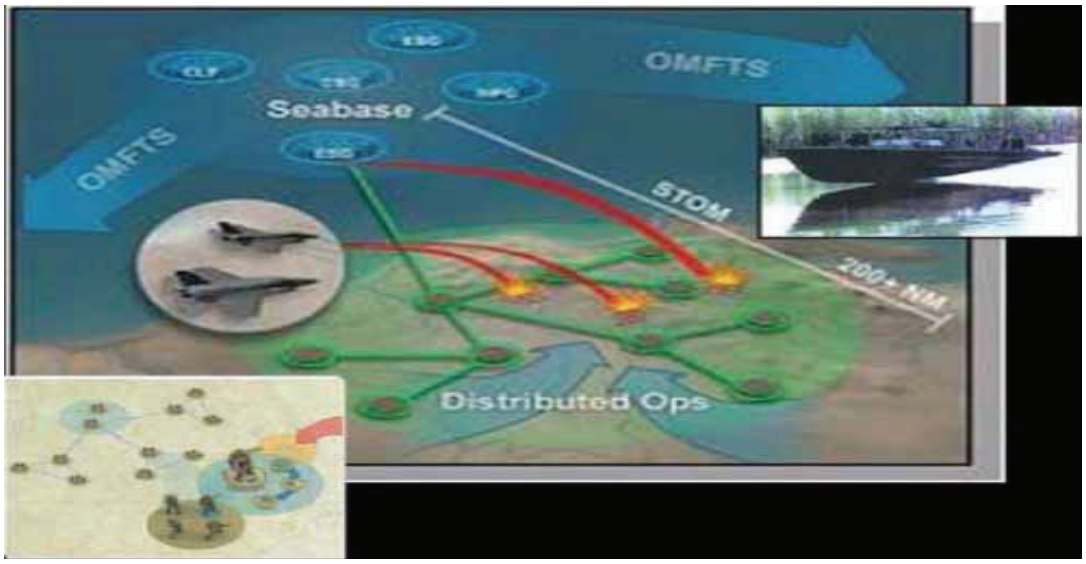
Vision: Attain maritime, littoral, and riverine access to denied areas and hold strategic and tactical targets at risk using lethal and non-lethal means.

Description: Naval forces must be able to attain maritime, littoral, riverine, and inland access (250 nm) to denied areas. They must maintain the ability to penetrate and operate in hazardous areas, where others cannot, in order to hold at-risk anti-access targets and deny sanctuary to adversaries. To accomplish this and provide access for our forces, it is necessary to improve our anti-submarine warfare (ASW) and mine warfare (MW) technologies and capabilities. Concomitant with this is the need to have distributed and networked surface, ground, and underwater sensors capable of providing real-time data to support short-notice actions of Naval forces. All this contributes to the battleshaping task that sets the stage for successful naval operations.

Objectives:

- Anti-Submarine and Mine Warfare
  - Rapid detection and clearing of underwater and land mines; neutralization from a distance
  - Advanced autonomy in unmanned robotic systems to expand ground reach and reduce threat exposure
  - Next-generation data and contact fusion to expand the regional ASW, mine and amphibious warfare operating picture to the theater level
- Distributed Surveillance
  - Distributed, networked, unmanned sensors/systems
  - Sustainable, intelligent, robust unmanned systems
  - Autonomous maritime reconnaissance to identify targets under all environmental conditions
- Battlespace Shaping
  - Non-lethal technologies to stop small vehicles and large ships
  - Battlespace shaping technology for enabling information operations
  - Decisive operations through a heavy electronic warfare (EW) attack area
  - Access to GPS-denied areas – alternatives to GPS technology
  - Operationally responsive use of space
  - Tagging, tracking, and locating technologies

4.8 Distributed Operations



Vision: Enable dispersed small units to dominate an extended battlespace through advanced warfighter training, assured network connectivity, enhanced situational awareness, and guaranteed access to logistics and fire support.

Description: Distributed operations (DO) is an operational technique that uses small units dispersed beyond the limits of mutual support in order to influence an extended battlespace. DO is practiced by both general purpose and special operations forces to achieve advantages over an enemy in both time and space. It requires the development of more lethal, agile, and survivable small units capable of operating across the full spectrum of operational challenges presented by the rise of complex hybrid warfare. Assured network connectivity will enable DO by providing small units with on-demand access to logistics and fire support. It will also permit the integration of C2 and ISR capabilities down to the squad level and will enable the increased situational awareness required for decentralized decision making. Naval technology investments will produce training systems that support the development of small unit leaders who thrive on chaos and uncertainty, adapt with unparalleled speed, and recognize/respond creatively to the extraordinary challenges of complex hybrid warfare. Additionally, these investments will mitigate the risks inherent in the execution of DO by developing advanced survivability, logistics, and Warfighter mobility capabilities. Finally, a common objective to all Naval DO technology development will be the improvement of small unit capabilities without adding to the individual Warfighter's combat load.

Objectives:

- Warfighter Preparation
  - Optimized physical readiness and enhanced cognitive performance
  - Immersive, synthetic systems for training and education

- Command and Control
  - Robust communications networks
  - Enhanced small-unit situational awareness through intelligence and alert dissemination
  - Small-unit blue force tracking systems
- Logistics
  - Automated logistics planning and monitoring
  - Sustainment demand reduction
  - Autonomous long-range logistics delivery
- Lethality and Survivability
  - Enhanced organic small-unit weapons effects
  - Enhanced small-unit surveillance and reconnaissance
- Mobility
  - Individual mobility and combat load reduction
  - Small-unit mobility

4.9 Naval Warfighter Performance

Vision: Enhance warfighter performance and decision-making under all warfighting conditions through human-system integration, operational health and casualty prevention.

Description: The warfighter is the key element in combat systems. The intelligence, adaptability, ingenuity and determination of our Sailors and Marines are critical to mission success. Battlefield situational awareness and effective individual and team decision-making are required even with highly automated

systems. Combat systems must be engineered to exploit the differing strengths of both human and machine elements and to maintain readiness under all warfighting conditions. To accomplish this end, we must keep our Sailors and Marines at the peak of their effectiveness while designing operational systems matched to warfighter capabilities. Decision support systems must be designed to supply the right information to the right people at the right time. Warfighters must be recruited, selected and trained efficiently to enhance effectiveness while reducing the time and costs of training. Critical knowledge, skills and abilities must be maintained and refreshed over time in the field and in the schoolhouse. Training systems and analytical tools are needed to address irregular warfare challenges involving non-traditional social, political, economic, ethnic, and religious factors that may affect the operational environment. Improvements to helmet, body armor and eye and ear protection must be designed that also improve comfort and ease of employment. The capability to respond quickly and effectively to injury is imperative. Health and fitness must be preserved to ensure warfighter resilience against physical and psychological threats throughout the continuum of peace and war. Methods to prevent and treat morbid outcomes that impact warfighter health must be progressive and forward-looking. To accomplish this end, we must continue to support cutting-edge medical innovation. Compact and lightweight medical technologies need to sustain combat readiness as far forward as possible with a reduced logistical footprint. New strategies are required to mitigate the adverse effects of sleep deprivation, fatigue, extreme heat and cold, high altitude, hyperbaric conditions, ergonomic load, information load and emotional stressors. Design principles from biological systems (including humans) will create new technologies and warfighting capabilities and enhance warfighter effectiveness.

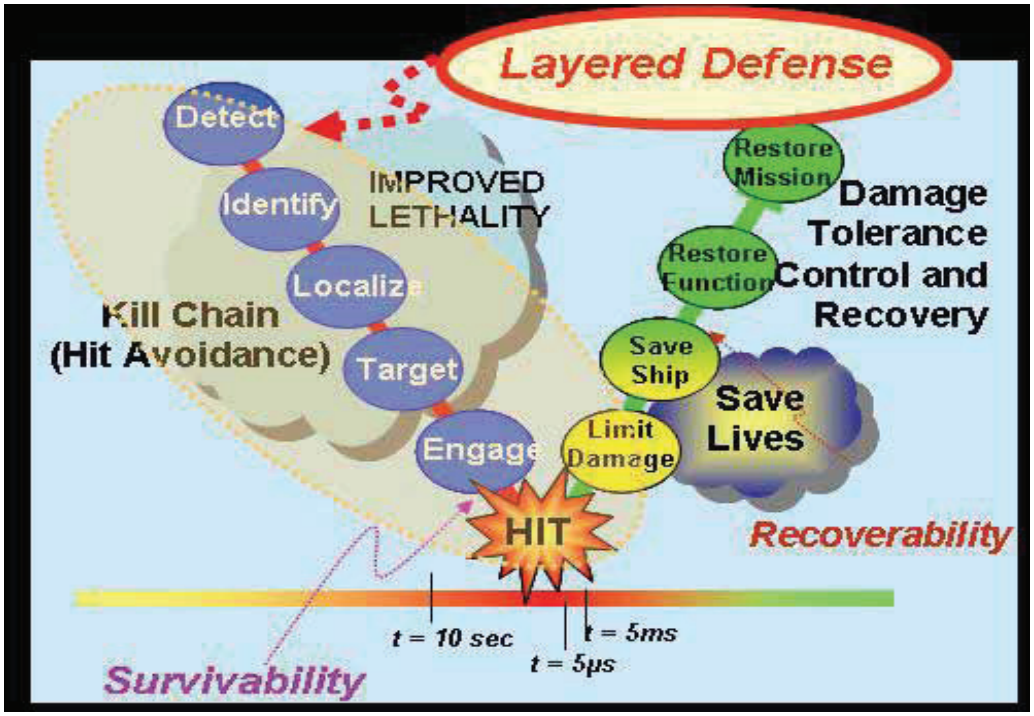
Objectives:

- Manpower and Personnel Management
  - Improve personnel recruitment, selection and assignment models and tools
- Training and Education
  - Develop technologies to shorten training time and maximize training impact
- Human-System Design
  - Develop design standards and engineering tools incorporating predictive models of human cognition and human-system interaction
  - Develop performance-based measures of personnel readiness and human-system performance
  - Incorporate the human element into design and operation of autonomous and robotic systems
- Warfighter Protection
  - Create advanced materials and improved design for lightweight body armor and equipment
  - Reduce incidence of noise-induced hearing loss

- Personnel signature management

- Operational Health and Casualty Prevention
  - Enhance first responder capability at point of injury and en-route care to reduce combat casualties
  - Mitigate health and performance risks in undersea operations

4.10 Survivability and Self-defense



Vision: Enable manned and unmanned naval platforms and forces to operate in hostile environments while avoiding, defeating and/or surviving attack by using innovative materials, sensors, countermeasures and counter-weapons.

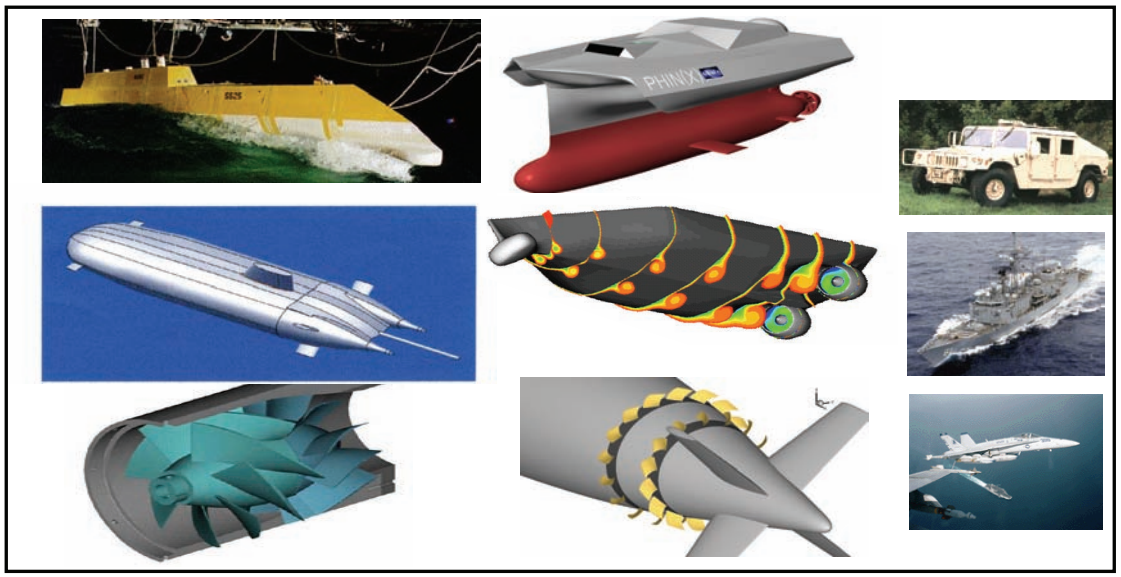
Description: Survivability and self-defense addresses defense against attack on U.S. and coalition forces at the individual, platform, unit, group, and theater levels. Success in this area hinges on three principles: avoid detection; if detected, defeat attacks or avoid being hit; and if hit, minimize the effects of damage. Attack comes from many sources and in the form of many different types of weapons. To avoid being targeted, the entire spectrum of signatures must be reduced (magnetic, acoustic, EO, IR, etc.). Stealth and own-signature suppression are critical pieces of this focus area. Incoming attack spans the range of small arms and hand-held weapons to ballistic and cruise missiles and undersea threats. They also include planted devices such as sea and land

mines and IEDs. Defense will include detection, identification and soft and hard kill defeat. Technologies must address a layered defense approach. Survivability will require platforms that are hardened, reacting, and damage-tolerant, and systems that may include automation to minimize impact of a successful attack.

Objectives:

- Platform Stealth
  - Reduce aircraft, above-water and subsurface signatures
  - Multi-spectral low observable (LO) technologies
- Force Protection
  - Detect and determine threat intent to interrupt kill chain
  - Detect and deter small boat and unmanned threats
  - Anti-swimmer technology
  - Non-lethal response
- Countermeasures and Counterweapons
  - Threat weapon tracking and weapon-countermeasure-sensor selections
  - Automated decision making and battle management aids
  - Low-false-alarm-rate, 360-degree detection
  - Hard kill and soft kill against threat kinetic weapons
  - Extend standoff to beyond threat damage range
  - Directed energy weapons for speed of light engagement
  - Counter-LO capabilities
- Survivable Platforms
  - Advanced platform construction materials
  - Damage-tolerant platform architectures
  - Automated damage-control focusing
  - Advanced materials for self-healing platforms

4.11 Platform Mobility



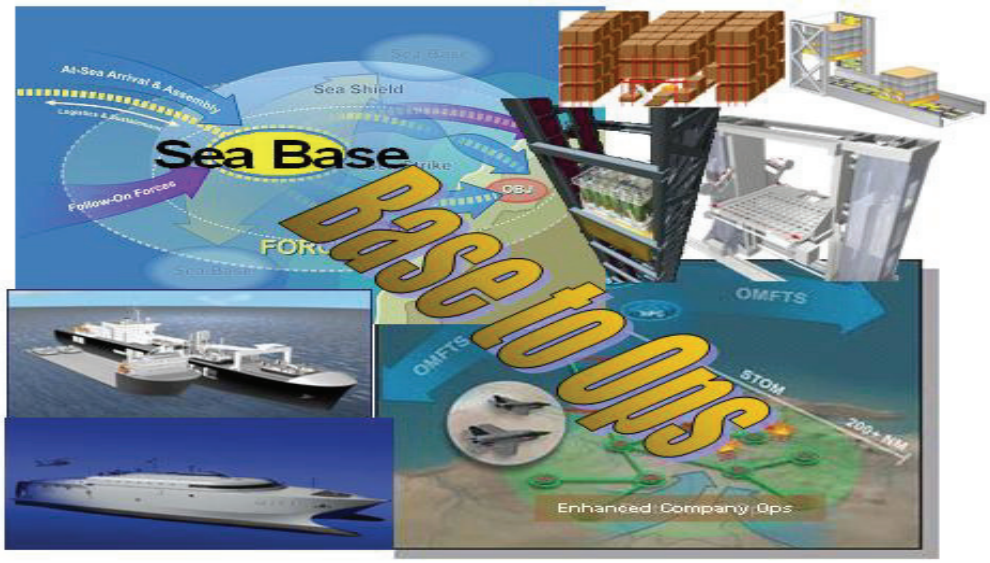
Vision: Develop agile, fuel efficient and flexible platforms capable of operating in any environment.

Description: Platform mobility centers on the science and phenomenological understanding of hydromechanics, aerodynamics, electrodynamics, electromechanics, materials, structural dynamics, intelligent control, and on the computational mechanics necessary to improve the design capability for advanced high-performance platforms. It also encompasses the systems required to power and control them efficiently. Key to this is the development of design tools capable of rapidly analyzing and evaluating novel air, ground, and sea/coastal/riverine platforms with advanced system performance characteristics. This focus area is driven by the development and delivery of system and equipment technologies that improve the performance and control of air, ground, and sea platforms to meet operational requirements under all environmental conditions.

Objectives:

- Efficient, High Endurance, High Speed Platforms
  - New and novel advanced platform design supporting new directions in Naval warfare (size, agility, modularity, etc)
  - Higher performance platforms at reduced fuel consumption
  - Efficient, all terrain, lighter, more agile ground vehicles including suspensions and drive trains
  - Manned vessel launch and recovery
  - Operator guidance tools
  - Lightweight, higher strength advanced composites and structural metals for optimized platform performance
- Vertical Lift Operations in Challenging Environments
  - High performance VTOL/VSTOL
  - High sea states launch and recovery technology to enable manned / unmanned air operations
- Autonomous and Unmanned Vehicle Mobility
  - New unmanned platform design technology
  - Advanced robotic systems for air, ground and sea combat
  - Unmanned vessel launch and recovery

4.12 Fleet and Force Sustainment



Vision: Provide the warfighter with accurate and timely supplies and equipment for Naval expeditionary operations, Joint or Combined forces ashore.

Description: Rapid re-supply for mobile forces with minimal logistic burden is necessary for effective operations. The comprehensive and responsive logistics support system, that includes air and sealift, replenishment ships, mobile repair facilities, and advanced logistics support hubs, underpins the ability of Naval expeditionary forces to operate regionally and worldwide. Furthermore, this ability to move and sustain Naval and other U.S. forces at great distances from our shores becomes even more crucial as we reduce our overseas base structure in response to post-Cold War realities. *Naval Power 21* transformed the Navy and Marine Corps approach from the traditional role of fleet replenishment to a completely new concept for supporting forward presence. The *Cooperative Strategy for 21st Century Seapower* reinforced the requirement for worldwide Fleet and Force sustainment. This new focus area responds to requirements that Naval forces be strategically positioned in important regional littoral areas of the world, both as representatives of national policy in peacetime and as lead elements of national and collective international response to crises, and to enable and sustain larger joint or combined military operations when necessary. The ability to sustain ourselves on-scene, for extended periods in important regions where U.S. security interests are affected, provides America with the opportunity to shape the environment with minimal dependence on the support of local foreign governments. While maintaining and improving fleet replenishment capabilities, sustainment will also need to expand and improve support to the Amphibious Assault mission, to encompass more diverse (smaller and larger) Expeditionary Forces and overcome the operational pause that usually follows an

initial assault. These capabilities will then expand to support the sustainment of joint combined missions.

Objectives:

- Sea based Sustainment
  - Flexible and responsive warehousing
  - At-sea assembly and reconstitution of forces
- Flexible and responsive delivery systems
  - Point-of-delivery systems
  - Heavy-lift vehicle launch and recovery
  - Ship-to-shore logistics
- Integrated Logistics
  - Common Operating Picture (COP) – Logistics
  - Autonomous re-supply systems
  - Source-to-Objective asset visibility

4.13 Total Ownership Cost

Vision: Reduce Total Ownership Cost of Naval platforms and systems through design tools, reduced maintenance, intelligent diagnostics, and automation.

Description: This focus area is dedicated to significantly increasing the affordability of current and future naval systems by reducing Total Ownership Cost while maintaining or improving system performance and platform availability to execute assigned missions. To implement this vision, we will attack the three main cost drivers comprising Total Ownership Cost for the Navy and Marine Corps: acquisition of platforms and systems, maintenance and life-cycle, and manpower. The cost component of affordability will be reduced by addressing platform manufacturing cost drivers and reducing manpower and material costs

associated with operations and maintenance of platforms and systems. The performance component of affordability will be increased by expanding the operating envelope and reliability of systems and components. The availability component of affordability will be improved by increasing service life and reducing man-hours required for scheduled and unscheduled maintenance.

Objectives:

- Platform Affordability
  - Advanced modeling and simulation for design, test and evaluation
  - Advanced Naval materials
  - Open architecture for hardware and software
  - Low-cost, reliable sensors and electronics
  - Innovative manufacturing technologies
- Maintenance and Lifecycle Cost
  - Condition-based maintenance systems
  - Anti-corrosion and anti-fouling technologies
  - Wear resistant life-time materials
  - Energy efficient systems
  - Software reliability
- Manning Optimization
  - Human systems integration
  - System automation
  - Autonomous systems

5.0 Naval S&T Program Implementation

ONR must manage a balanced S&T portfolio to produce both knowledge and products that contribute to long-term DON strategic goals (**See Figure 1, Section 2, page 2**). Strategic tenets for investment include: impact, relevance, innovation, appropriate level of risk, multidisciplinary opportunities, quality performers, critical resource level, and clearly developed programs.

5.1 Discovery and Invention (D&I): This area consists of Basic Research (BA 6.1) and the early stages of Applied Research (BA 6.2). D&I is the seed corn for future naval technologies and systems. It provides technology options, maintains critical U.S. S&T capacity, and develops the next generation of the S&T workforce. The D&I portfolio, by design, has a broad focus, and programs are selected based on potential naval relevance and technology opportunity. An important aspect of ONR's D&I is the sustained investment in unique naval scientific disciplines and those other areas that benefit expeditionary warfare. These unique disciples are regarded as National Naval Responsibilities (NNRs). They are Ocean Acoustics, Underwater Weaponry, Naval Engineering and Underwater Medicine. To provide maximum return for the DON investment, D&I

investments leverage other service, governmental department, industry, international and general research community investments. Most of the D&I program is performed by university researchers, but both the NRL Base Program and the In-House Independent Research (ILIR) and In-House Applied Research (IAR) programs executed by the Naval Warfare Centers form key parts of the program.

5.2 Leap Ahead Innovations: Innovative Naval Prototypes and Swamp Works projects comprise the bulk of this S&T investment. These are technology investments that are potentially "game changing" or "disruptive" in nature. In this investment category we are willing to accept higher risk in an effort to produce higher payoffs for the warfighters.

- **Innovative Naval Prototypes** – These programs explore high 6.2 and 6.3 technologies that can dramatically change the way Naval forces fight. Programs in this category may be disruptive technologies that, for reasons of high risk or radical departure from established requirements and concepts of operation, are unlikely to survive without top leadership endorsement, and, unlike FNCs, are initially too high risk for a firm transition commitment from the acquisition community. INPs should be identified based on a balanced combination of naval need and technology exploitation. Investments should be planned with the critical mass needed to achieve a level of technology maturity suitable for transition in four to eight years. Program Managers (PMs) are primarily selected from ONR, and in order to help facilitate the transition to the acquisition community, Deputy PMs are typically chosen from the Acquisition community. The CNR, in consultation with senior Navy and Marine Corps leadership, identifies candidate INPs that are then forwarded to Naval S&T Corporate Board for approval / disapproval.

- **Swamp Works** – These programs, although potentially high risk and disruptive in nature, are smaller than INPs and are intended to produce results in one to three years. Swamp Works efforts have substantial flexibility in planning and execution, with a streamlined approval process, shortening the innovation time cycle. Although a formal transition agreement is not required, Swamp Works programs should have strong advocacy outside ONR, either from the acquisition community or the fleet. Frequently, Swamp Works products are inserted into fleet experimentation, and if successful can provide the impetus for new acquisition requirements.

5.3 Acquisition Enablers: This portion of the S&T portfolio centers on the Future Naval Capabilities (FNCs). These work to mature technology into requirements-driven, transition-oriented products in the late stages of applied research and Advanced Technology Development (BA 6.3). FNCs provide

enabling capabilities to fill gaps OPNAV and MCCDC requirements analyses identified in the Naval strategy and *Naval Power 21*. The Technology Oversight Group (TOG) determines the priorities for selecting FNC investments. FNC integrated product teams lead the management of individual FNCs to ensure close connectivity between requirements, technology development, and acquisition. In addition to the FNCs, ONR also uses Small Business Innovation Research (SBIR), Manufacturing Technology (MANTECH) programs, and Rapid Technology Transition (RTT) to foster naval acquisition programs' success.

5.4 Quick Reaction and other S&T: This includes quick-reaction projects responsive to the immediate needs or compelling innovation identified by the fleet, operating forces, or Naval leadership.

- **Tech Solutions** – This program addresses fleet or force input with research to provide an S&T solution that meets or exceeds the need, with short-term programs and rapid solutions. They respond directly to requests from deck-plate Sailors and Marines.

- **Experimentation** – The NWDC and the MCWL, in partnership with ONR, explore future warfighting concepts and evaluate the capability potential of emerging technologies.

5.5 Naval Research Laboratory (NRL): NRL is the DON's corporate S&T laboratory, performing science and technology in support of Naval needs. Since 1923, NRL's mission-oriented research and development programs have made significant contributions to the warfighting capabilities of the Navy, Marine Corps and the nation. The laboratory's work has yielded new and improved materials, techniques, equipment, systems, as well as new ocean, atmospheric, and space science and related technologies. A few examples include: the Clementine spacecraft, specialized weather models in support of military operations, the "Little Buddy" ALE-50 decoy, the InfraLynx assured communications system, the Silent Guardian biosurveillance technology, and lightweight body armor. NRL provides:

- Primary in-house research in physical, engineering, and environmental sciences
- Broadly based exploratory and advanced development programs in response to naval needs
- Extensive, multidisciplinary support to the Naval Warfare Centers
- Space, and space systems technology development and support

5.6 Global Technology Awareness: As the level of research and development activity continues to accelerate outside of the United States, and access to information and knowledge becomes more rapidly and widely available, it is increasingly critical that U.S. Naval S&T maintain close connections with the

global research and development community. This allows us to capitalize on the global intellectual capacity that can provide innovative solutions to naval challenges, and also to maintain awareness of potential technological surprises and threats. To take advantage of the rapid pace of global innovation, and to ensure that Naval S&T challenges benefit from the broadest range of ideas and approaches available, ONR is working to build strategic collaborations that connect U.S. research and development organizations, such as NRL, DARPA, NASA, NSF, warfare centers, and the fleet/force with international academia, industry, government laboratories, and research consortia.

Many tools are used to build these linkages to the global technology community. These include: direct scientific engagement by NRL and ONR scientists; establishment of international agreements and exchanges between government research agencies, often facilitated by the Navy International Programs Office; multilateral collaborations (TTCP, NATO, *etc.*); and, many other *ad hoc* arrangements. In addition to these diverse approaches, Naval S&T has an international arm, ONR Global, to enhance collaboration and access.

ONR Global deploys scientists and engineers around the world to develop partnerships between the international and U.S. research communities in areas of naval relevance; to discover leading edge scientific advances and innovation; and to communicate emerging national and regional technology trends to avoid potential technology surprises. Since 2003, ONR Global has been engaged in more than 70 countries. Future engagement is being closely coordinated with the fleet/force to ensure that Naval S&T is positioned to assist in carrying out the theater security cooperation priorities of the combatant commands while providing scientific solutions to their needs. ONR Global also directly embeds science advisors within the fleet/force to facilitate global awareness, to ensure that operating force capability needs are quickly and effectively communicated to the Naval S&T community, and to facilitate the delivery of Naval S&T solutions to the fleet/force at the right time.

5.7 Naval Research Enterprise (NRE): Across the broad spectrum of technical challenges posed by the Navy's operational environments, ONR's commitment to excellence in science and technology demands the ability to reach out and employ resources in government, academia and industry research organizations in the United States, as well as those made available by the efforts of ONR Global throughout the world. Future operational security in naval environs depends upon a cadre of dedicated and competent scientists and engineers that can deliver superior warfighting capability to our Sailors and Marines. Those scientists and engineers are resident at the NRL, Naval Warfare and Systems Centers, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), colleges and universities, innovative businesses, and industry laboratories that together, form an association known as the "Naval Research Enterprise".

In addition to responding to requirements from our warfighters, the NRE looks to meet long-term emerging needs and mitigate the risk of technological surprise. The NRE helps with visibility into the evolution of knowledge in the basic sciences while fostering a culture of transferring technological capability into the hands of naval warfighters. The DON's sustained commitment to science and technology enables ONR and the entire NRE to focus on building knowledge through discovery and invention. Additionally, it sustains the highly skilled and dedicated people required for systems, platforms, sensors, and weapons needed to carry out current and future missions.

5.8 Science and Engineering Workforce: The researcher base program and science and engineering workforce programs support the NRE as a whole. The D&I portfolio supports approximately 3,000 students annually. Specifically, ONR offers a Student Internship Program, the Student Temporary Employment Program and the Naval High School Science Awards Program, which aim to reward scientific achievement and encourage students to pursue careers in science and engineering. The ONR website provides specific information for these opportunities (See Appendix A). The science and engineering workforce programs educate and encourage the academic and professional development of scientists and engineers in fields relevant to disciplinary research, and establish partnerships among academia, industry, and Naval laboratories. ONR works to increase minority institution and small business participation in the NRE through education programs, grants, contracts and cooperative agreements with Historically Black Colleges and Universities/Minority Institutions. ONR's Small Business Innovation Research/Small Business Technology Transfer programs reach out to tap the innovation provided by small business.

5.9 Interagency Coordination and Alliance: The Naval S&T investment is coordinated though the Defense S&T Reliance 21 Program and similar cooperative programs to leverage efforts by other services and DoD agencies, and to achieve economies and synergies. Each year, 10-15 percent of the DON 6.2/6.3 program supports multi-service/agency-funded and -managed projects to develop technologies and capabilities that have DoD-wide relevance. Key joint programs currently being funded are the Versatile, Affordable, Advanced Turbine Engine Program to develop the next generation of high efficiency, high-thrust-to-weight-ratio turbine engines and the Weapons of Mass Destruction Detection Program that addresses national maritime and port security through the development of technologies for standoff detection of WMD's and component nuclear materials on ships at sea.

ONR's senior leadership and program officers routinely meet with other service counterparts to exchange information and identify opportunities to collaborate or to conduct complementary research efforts. In addition, ONR and NRL program managers reach out to the larger technical community and collaborate with non-

DoD agencies such as NSF, NASA, and DOE. ONR also coordinates with the United States Coast Guard (USCG) and has an officer on-site who serves as direct Coast Guard liaison and helps coordinate ONR efforts with the Department of Homeland Security in global maritime domain awareness and in combating terrorism.

5.10 Measuring Success: Measures of S&T success should include metrics that represent key outputs: knowledge, transitions, and people. Metrics help manage high-risk revolutionary science and technology. They also communicate the value of the Naval S&T investment to senior leadership.

S&T Output	Metric
Knowledge	Refereed Papers
	Patents/Licenses
	Citations
Transitions	
	Capability Gaps Proposed
	% Capability Gap Proposals Funded
	% at Transition Objective in 3-5 Years
	% Taken by Acquisition
	% in Fleet
People	Students Supported
	Advanced Degrees Completed
	Program Participants Entering NRE Workforce

Figure3: Metrics to Evaluate S&T Portfolio.

5.11 Business Processes: More than 80 percent of ONR sponsored S&T is awarded to external performers in academia, industry, and the NRE; therefore, efficient and effective business processes are vital to achieving our S&T objectives. Business operations include:

- Grant and contract administration
- Contracting activities and policy
- Acquisition and research business policy
- Information and statistical reporting processes
- Human Resource Management
- Intellectual property policy with patent and trademark oversight
- Stakeholder communication and engagement

6.0 Execution of DON Vision from ONR Perspective

The Naval S&T visions and objectives articulated in Section 4 collectively represent the overall roadmap for our S&T investments. Bringing this vision to fruition requires the best efforts of the entire ONR leadership team. Section 5 provided a brief explanation of the management processes for the four major categories of the S&T investment portfolio. The focus areas include investments from of all parts of S&T portfolio and cut across ONR's departmental organization. This section provides a snapshot of the process that ONR uses to manage the focus areas in order to execute the Naval S&T Strategic Plan.

Management of Focus Areas:

- Each of the 13 Focus Areas is assigned a Focus Area Leader, a Senior Executive Service S&T manager, who is given broad authority to work across ONR departmental lines.

- The Focus Area Leader is responsible for generating detailed roadmaps that articulate the progression of products from basic research through transition to identified customers.

- ONR leadership subjects each Focus Area to an exhaustive annual review. Each Focus Area is scrutinized not only for how well it is executing its roadmap, but also for how well that execution lines up with the strategy and vision. Programs and projects which are not executing, or which are found to be out of line with the vision, are at risk of being terminated and their resources re-allocated.

The supporting processes for bringing the S&T visions and objectives to reality are the key to the successful implementation and execution of the Naval S&T Strategic Plan. They represent the intersection of Navy and Marine Corps visions, challenges and opportunities provided by advances in S&T. Our investments over time will ensure the continued technological superiority advantage of Naval forces, so that no Sailor or Marine will ever find themselves in the middle of a fair fight. Our S&T investments, when mature, will result in future Naval forces that have:

- Domination of the electro-magnetic spectrum and cyber space
- Implemented directed energy weaponry – fighting at the speed-of-light
- Achieved persistent, distributed surveillance in all domains
- Comprehensive MDA with large vessel stopping and WMD detection for EMIO
- Affordable platform design and construction

- Adaptive, wireless communications networks
- Decision tools for commanders that provide tactical advantage
- Determination of threat intent thru social and cultural understanding
- Lighter, faster, more lethal Marine Forces
- Accelerated team training and skill development
- Increased operational effectiveness through more efficient power and fuels
- Responsive and visible logistics to enable distributed forces
- Greater tactical advantage through superior knowledge and use of operational environments

7.0 Summary

The overriding goal of this Naval S&T Strategic Plan is to provide the vision and key objectives guiding the essential science and technology efforts that will assure the continued supremacy of U.S. Naval forces in the 21st century. This plan implements the current guidance and direction of our senior civilian and military leadership. It focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare. It puts us on a path toward maturing and transitioning enhanced naval capabilities, such as persistent ISR and dominance of the EW spectrum, and toward pursuing revolutionary advances, such as speed-of- light weapons. This strategy will be reviewed and approved by the Naval S&T Corporate Board every two years to ensure its continued relevance. It provides a means and framework to communicate with decision makers and the various external communities that interact with Naval S&T. Inside ONR, this plan will guide our investment planning and decisions. It is also intended to broaden our reach into the scientific community as well as into industry. The plan will be posted on the ONR website (www.onr.navy.mil) as a gateway for industry and academia into the center of Naval S&T.

Appendix A: References and Web Links

References

- **National Strategic Guidance**
  - National Security Strategy of the United States of America (March 2006)
  - National Defense Strategy of the United States of America (March 2008)
  - National Military Strategy of the United States of America (2004)
  - National Strategy for Maritime Security (2005)
  - National Plan to Achieve Maritime Domain Awareness (2005)
- **Joint and Naval Strategic Guidance**
  - Joint Operating Environment (2008)
  - Marine Corps Vision and Strategy 2025 (2008)
  - A Cooperative Strategy for the 21st Century Seapower (2007) http://www.navy.mil/maritime/MaritimeStrategy.pdf
  - Department of the Navy Objectives for FY 2008 and Beyond (2007) http://www.fmo.navy.mil/mic/docs/2008_DON_Objectives-signed.pdf
  - Naval Operations Concept (2006)
  - Navy Strategic Plan (August 2006), in support of POM 2008
  - Navy Strategic Plan (November 2007), in support of POM2010
  - Naval Enterprise Input - NOTAL
  - CNR Fleet Engagement (2006) – NOTAL
  - Sea Power 21 (2002)
  - Naval Power 21 (2002)
- **Defense Science and Technology Guidance**
  - DoD Research and Engineering Strategic Plan (2007)
  - Marine Corps S&T Strategic Plan (2007)
  - Navy Expeditionary Combat Enterprise Strategic Plan (2008) – NOTAL http://www.necc.navy.mil/

- Naval Aviation Enterprise S&T Objectives (2008) – NOTAL http://www.navair.navy.mil/index.cfm?fuseaction=nae.default
- Naval Sea Systems Command & Affiliated Program Executive Offices S&T Needs (2006) – NOTAL
- Undersea Enterprise S&T Technical Areas of Interest (2006) – NOTAL
- Army Science & Technology Master Plan (2007) - NOTAL

Web Links

Point of Contact Listing: http://www.onr.navy.mil/media/poc/

For more information on the following topics, please see the associated websites:

- **FNC:** http://www.onr.navy.mil/fncs/
- **SBIR at ONR:** http://www.onr.navy.mil/sci_tech/3t/sbir_sttr/sbir_onr.asp ,
- **SBIR at Navy:** http://www.navysbir.com/
- **MANTECH:** http://www.onr.navy.mil/sci%5Ftech/3t/mantech/
- **RTT:** http://www.onr.navy.mil/sci_tech/3t/transition/
- **TECH SOLUTIONS:** https://www.onrglobal.navy.mil/techsolutions/login.asp?backlink=/techsolutions/Default.asp
- **SWAMPWORKS:** http://www.onr.navy.mil/01/swampworks/

Appendix B: Naval S&T Research Sub-Areas

Naval S&T Focus Area	Objective Categories	S&T Research Areas
Power & Energy	• Energy Security • Efficient Power and Energy Systems • High Energy and Pulse Power	• Advanced Naval Power Systems • Air Platform Power • Power Electronics • Personal Power • Bio-derived Materials and Systems • Functional Materials
Operational Environments	• Mobile Autonomous Environmental Sensing • Match Predictive Capabilities to Tactical Planning Requirements • Adapt Systems to the Environment	• Unmanned Sea Vehicle Technologies • Unmanned Air Vehicles • Intelligent and Autonomous Systems • Bio-sensors, Bio-processes, and Bio-inspired Systems • Physical Oceanography • Marine Meteorology • Ocean Acoustics • Littoral Geosciences, Optics and Biology • Space Environmental Effects • Marine Mammals • ASW Performance Assessment
Maritime Domain Awareness	• Pervasive and Persistent Sensor Networks • Identification of Hard Targets through Diverse Sensing • Sensor / Data Integration and Threat Assessment	• Information Processing, Discovery and Presentation • Networked Sensors • Communications and Networks • Intelligent and Autonomous Systems • ASW Surveillance • Bio-sensors, Bio-processes, and Bio-inspired Systems • ISRT-ESM • Nanometer Scale Electronic Devices and Sensors • Navigation & Precision Timekeeping • Automated Image Understanding • Spacecraft Technology • WMD Detection
Asymmetric & Irregular Warfare	• Irregular Warfare Battlespace Awareness • Social-Cultural Domain Analysis • Influence Operations Enablers • Advnced Countermeasures.	• Unmanned Sea Vehicle Technologies • Unmanned Air Vehicles • Intelligent and Autonomous Systems • Automated Image Understanding • Information Processing, Discovery, Integration and Presentation • Social, Cultural and Behavioral Modeling • Nanometer Scale Electronic Devices and Sensors • EW Attack • Counter IED • Non-Lethal Weapons
Information Superiority and Communication	• Rapid, Accurate, Decision-Making • Communications and Networks with increased throughput • Cyber Warfare	• Information Processing, Discovery, Integration and Presentation • Decision Support Tools • Automated Image Understanding • Human Factors Organizational Design and Decision Research • Communications and Networks • Computational Analysis • Nanometer Scale Electronic Devices and Sensors • Solid State Electronics • Information Assurance and Anti-Tamper

Naval S&T Focus Area	Objective Categories	S&T Research Areas
Power Projection	• Future Navy Fires • Control Collateral Damage • Time-Critical Strike • Small Unit Combat Power • Combat-Insensitive Munitions	• Advanced Energetics • Directed Energy • Electromagnetic Guns • High Speed Weapons Technologies • Precision Strike • Undersea Weaponry • Mining • Non-Lethal Weapons • EW Attack • Expeditionary Firepower
Assure Access and Hold at Risk	• Anti-Submarine and Mine Warfare • Distributed Surveillance • Battlespace Shaping	• Anti-Submarine Warfare Surveillance • Mine Neutralization • Intelligent and Autonomous Systems • Networked Sensors • Spacecraft Technology • Nanometer Scale Electronic Devices and Sensors • Solid State Electronics • Functional Materials • EW Attack • ISRT-ESM • Large Vessel Stopping • Non-Lethal Weapons • Navigation & Precision-Timekeeping
Distributed Operations	• Warrior Preparation • Command and Control • Logistics • Lethality and Survivability • Mobility	• Training, Education and Human Performance • Expeditionary C4 • Communications and Networks • Expeditionary Logistics • Expeditionary Firepower • Precision Strike • Expeditionary ISR • Intelligent and Autonomous Systems • Special Warfare/EOD • Expeditionary Maneuver / Individual Mobility
Naval Warfighter Performance	• Manpower and Personnel Management • Training and Education • Human-System Design • Warfighter Protection • Operational Health and Casualty Prevention	• Manpower and Personnel • Training, Education and Human Performance • Human Factors, Organizational Design and Decision Research • Undersea Medicine • Casualty Care and Management • Casualty Prevention • Biosensors, Bioprocesses, and Bio-Inspired Presentations • Structural Materials

Naval S&T Focus Area	Objective Categories	S&T Research Areas
Survivability and Self-Defense	• Platform Stealth • Force Protection • Countermeasures & Counterweapons • Survivable Platforms	• Undersea Weaponry • Torpedo Defense • Directed Energy • Sea Platform Survivability • Air Platform Survivability • Functional Materials • Solid-State Electronics • EW Attack • ISRT-ESM • Expeditionary Force Protection • Non-Lethal Weapons
Platform Mobility	• Efficient, high-endurance, high-speed platforms • Vertical Lift Operations in Challenging Environments • Autonomous and Unmanned Vehicle Mobility	• Advance Sea Platforms • Air/Ground Vehicles • Air Propulsion • Advanced Naval Power Systems • Expeditionary Manuever • Structural Materials • Functional Materials • Unmanned Air Vehicles
Fleet/Force Sustainment	• Sea-Based Sustainment • Flexible and Responsive Delivery Systems • Integrated Logistics	• Advanced Sea Platforms • Seabase Enablers • Expeditionary Logistics • Intelligent and Autonomous Systems • Human Factors, Organizational Design, and Decision Research
Total Ownership Cost	• Platform Affordability • Maintenance and Lifecycle Cost • Manning Optimization	• Advanced Sea Platforms • Air/Ground Vehicles • Complex Software Systems Tools • Information Assurance and Anti-Tamper • Manufacturing Science • Affordability/Reduced Platform Life-Cycle Cost • Advanced Naval Power Systems • Power Electronics • Biosensors, Bioprocesses, and Bio-inspired Systems • Structural Materials • Materials, Computation and Prediction • Environmental Quality • Intelligent and Autonomous Systems

Appendix C: S&T Glossary and Acronyms

Glossary

Capability Gaps: Describe those areas where the Navy and Marine Corps have current or projected warfighting capability shortfalls. Science and technology investments may be required to support projects / programs that mitigate or close a capability shortfall. OPNAV (N-8) and HQMC (DC CD&I) identify these capability gaps from analysis of DoD approved warfare scenarios.

Leveraged Funds: Are outside funds (non-DoN) used to support Naval S&T projects. An example would be the anticipated use of a deliverable from a DARPA (or USAF, AFRL, *etc.*) S&T project.

Project Sponsor: The entity that has agreed to accept the product of the S&T effort and has set down the specific exit criteria that must be met to qualify for transition.

Resource Sponsor: The OPNAV organization that programs the resources (R&D and procurement) to support the transition the S&T effort to a Program of Record. In the Navy, this is the OPNAV staff organization that staffs the Fleet requirement through the formal certification process. The Marine Corps does not have resource sponsors. DC CD&I is responsibility for staffing requirements.

S&T Objective: Science and Technology Objective (STO) is a broad term to describe an area the Navy and marine Corps consider important for tasking and/or investment in order to achieve a major technological advancement. While a STO may partially fill a capability gap, fully closing the gap will generally require an investment in multiple STOs.

S&T Project Progression: Shift of a technology development to a higher category of S&T funding and/or technology readiness, after it meets documented project requirements.

S&T Project Success: The achievement of project objectives that results in Progression, Transition, Technology Deployment, or Increased Knowledge.

S&T Project Transition: Shift of a technology development from S&T funding to other funding categories that directly or indirectly supports the acquisition of the warfighting capability. For example, the project moves into an acquisition program of record and Industry incorporates the technology into a product via Patent Licensing, Work for Private Party agreement, or Cooperative Research and Development Agreement (CRADA).

Science: The investigation of material phenomena, a pursuit of knowledge, an understanding of phenomenology

Technology: The application of science to industrial or military objectives

Transition Manager: The Program Management Office that agrees to map the technology into the platform or system development Program of Record.

List of Acronyms

ACMC	Assistant Commandant of the Marine Corps
AIW	Asymmetric and Irregular Warfare
ASN	Assistant Secretary of the Navy
ASW	Anti-Submarine Warfare
BA	Budget Activity
C2	Command and Control
C4	Command, Control, Communications, and Computers
CBRNE	Chemical, Biological, Radiological, Nuclear, and High-yield Explosive
CIED	Counter Improvised Explosive Device
CNR	Chief of Naval Research
COP	Common Operating Picture
DARPA	Defense Advanced Research Projects Agency
D&I	Discovery and Innovation
DO	Distributed Operations
DoD	Department of Defense
DOE	Department of Energy
DON	Department of Navy
EC	Enabling Capability
ECO	Enhanced Company Operations
EMIO	Enhanced Maritime Intercept Operations
EO	Electro-optical
EOD	Explosive Ordnance Disposal
EW	Electronic Warfare
FNC	Future Naval Capabilities
GPS	Global Positioning System
GWOT	Global War on Terror
HQMC	Headquarters Marine Corps
IAR	In-House Applied Research
IED	Improvised Explosive Devices
ILIR	In-House Independent Research
IM	Insensitive Munitions
IR	Infrared
ISR	Intelligence, Surveillance, and Reconnaissance
ISRT - EM	Intelligence, Surveillance, Reconnaissance, and Targeting - Electromagentic

IW	Irregular Warfare
LO/CLO	Low Observable/Counter Low Observable
MANTECH	Manufacturing Technology
MCCDC	Marine Corps Combat Development Command
MCM	Mine Countermeasures
MCWL	Marine Corps Warfighting Laboratory
MDA	Maritime Domain Awareness
MIO	Maritime Interception Operation
M&S	Modeling and Simulation
MW	Mine Warfare
NAE	Naval Aviation Enterprise
NASA	National Aeronautics and Space Administration
NECC	Naval Expeditionary Combat Command
NECE	Naval Expeditionary Combat Enterprise
NATO	North Atlantic Treaty Organization
NM	Nautical miles
NRAC	Naval Research Advisory Committee
NRL	Naval Research Laboratory
NRE	Naval Research Enterprise
NSB	National Science Board
NSF	National Science Foundation
NWDC	Navy Weapons Development Command
OA	Operational Adaptation
ONR	Office of Naval Research
OPNAV	Office of the Chief of Naval Operations
P-IED	Projected Improvised Explosive Device
RDA	Research Development and Acquisitions
RTT	Rapid Transition Technology
SBIR	Small Business Innovation Research
SIGINT	Signals Intelligence
S&T	Science and Technology
STOM	Ship to Objective Maneuver
TOG	Technology Oversight Group
TTCP	Technology Transfer Control Plan
UARC	University Affiliated Research Center
USMC	United States Marine Corps
VCNO	Vice Chief of Naval Operations
VTOL	Vertical Take-off or Landing
VSTOL	Vertical/Short Take-off or Landing
WMD	Weapons of Mass Destruction

OFFICE OF NAVAL RESEARCH